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PRACTICAL CRYSTAL DRAWING

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The ordinary method of crystal drawing involves the previous preparation of an "axial-cross" upon which the intercepts of the crystal faces may be laid off, yielding the directions of the edges; the perspective drawing is then obtained by a process of truncating and bevelling a "primitive figure." It presents the following disadvantages:

1. The derivation of the axial-cross alone is somewhat laborious in the case of a monoclinic crystal, and is decidedly irksome in the case of a triclinic crystal.

2. Much judgment and practice are needed in making successive truncations; otherwise the final result is not a faithful representation of the crystal.

3. The orthodox position for the axial-cross is not suitable for all crystals. The preparation of a suitable axial-cross for any but the normal position is a difficult matter for which no general directions can be given.

In the year 1891 Professor Victor Goldschmidt² introduced an entirely new method of drawing, based on the gnomonic projection, and this method would appear to be preferable, for the following reasons:

1. No axial-cross is required and the only construction lines needed, the guide-line (*Leitlinie*) and angle-point (*Winkelpunkt*) may be drawn in a few minutes.

2. All truncations are effected at the outset in an orthogonal projection of the top of the crystal. This drawing is made as a free-hand sketch before measurement, and afterwards accurately from the gnomonic projection.

3. As will be seen below, a preliminary examination of the gnomonic projection will show whether the orthodox drawing position is suitable or not. The alteration of this standard position is a matter involving no extra labor whatever.

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² *Z. Kryst. Min.*, 19, 352, 1891.

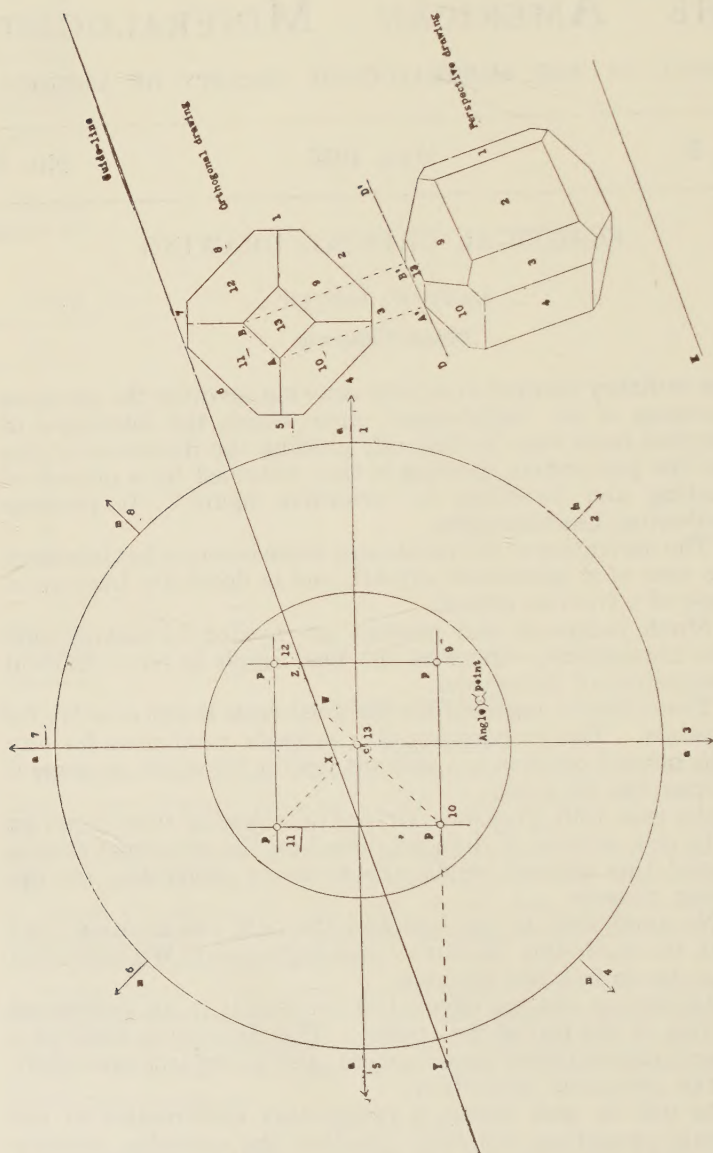


FIG. 18.

The most satisfactory way of illustrating Professor Goldschmidt's method is to give a concrete example of the drawing of a simple crystal. A crystal of vesuvianite (idocrase) was chosen for this purpose; the gnomonic projection and drawing are given in Fig. 18, on page 90.

The orthogonal projection is made normal to the basal plane. Since in the gnomonic projection all zones become straight lines, the direction of the edge between any two crystal faces in orthogonal projection is perpendicular to the zone line in which they lie. In the orthogonal drawing, then, to find the direction of the edge between the two faces 9 and 10, place a ruler¹ on the zone 9-10 in the gnomonic projection and with a right-angled triangle or set-square obtain the perpendicular direction. In the case of an edge between a prism and a terminating face, such as that formed by the faces 2 and 9, the required direction will be perpendicular to that of the direction-line (arrow) representing the prism.

In preparing the orthogonal drawing it is convenient to draw the prism outline first. In the example given the faces were drawn in the following order: the prisms 2-4-6-8; the pinacoids 1-3-5-7; the basal pinacoid 13, and finally the pyramids 9-10-11-12.²

It need scarcely be stated that in the preparation of the orthogonal drawing of an idealized crystal every care must be taken to preserve every equality of dimensions demanded by the symmetry; for example, in drawing the prism outline, the edges 2-4-6-8 must be of equal length. If the drawing is to be a "portrait," reproducing the actual proportions of the crystal, this important aid to correct work will not be available and the best judgment of the worker must be employed to secure the correct balance of the various parts of the figure. It is also important that the scale of the drawing should be large; with a complicated figure it is impossible to secure accurate results in a small, crowded plan. Lines should be drawn with a wedge-sharpened hard pencil so that the ruler may be placed accurately upon the point thru which the line is to be drawn. If the crossing points of lines are marked by pricking with a needle point and circling the hole with a soft pencil it will be much easier to find them again and to draw accurately thru them should occasion arise.

¹ A heavy steel straight-edge will be found convenient, tho not necessary.

² Before starting the orthogonal drawing, the ρ values of the inclined faces should be carefully considered. Faces with high ρ values will appear very much wider in the perspective drawing than in the plan, and faces with low ρ values very much narrower. Allowance must be made for this when deciding the width of the faces in the orthogonal drawing. In practice the width can be estimated by the eye but the mathematical relation may be used as follows: In a right-angled triangle ABC in which C is 90° and A is ρ , let AB be the width of a face in perspective drawing; then AC will be the apparent width in the plan.— $\frac{AC}{AB} = \cos \rho$ or $AC = AB \cos \rho$.

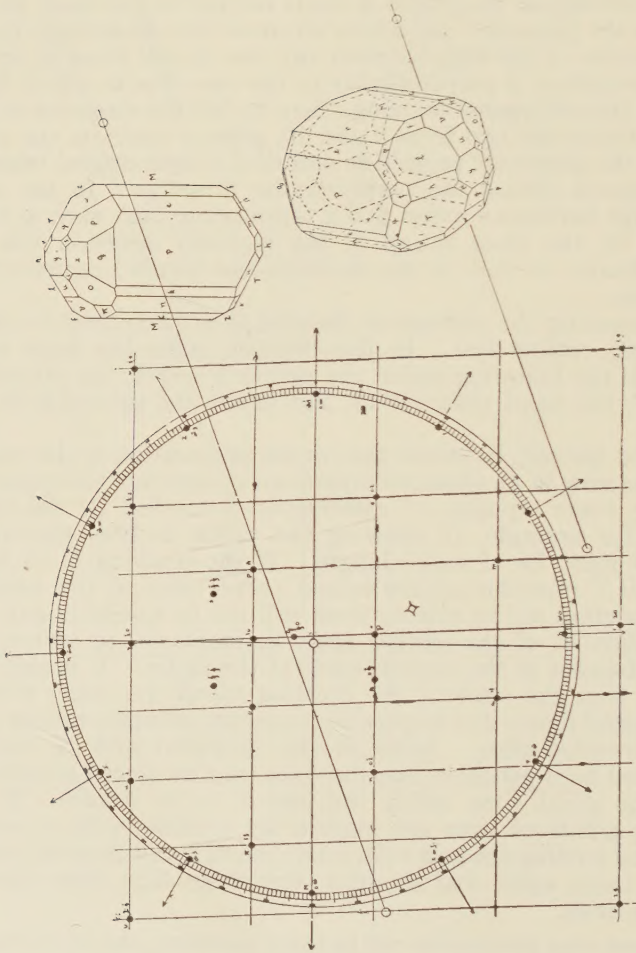


FIG. 19.

The parallel-perspective drawing is made from the orthogonal drawing with the help of the gnomonic projection, guide-line and angle-point. To obtain such a drawing in the generally accepted position the guide-line and angle-point are to be constructed according to the following directions (taken from Prof. Goldschmidt's paper above cited):

Draw a vertical diameter of the 5 cm. unit circle, AB. From B lay off to the right a chord $BF = \frac{1}{3} OB$. Draw the diameter FOE and on OE lay off $OD = \frac{1}{6} OB$. Thru D draw a line all the way across the projection perpendicular to FOE. This is the *guide-line*. Draw the radius OJ parallel to the guide-line. The point at which OF is cut by a circle with center D and radius DJ is the *angle-point*, GP. Geometrical proof of the correctness of the methods to be used will be found in a supplementary note following this paper.

The position of the first crystal edge to be drawn,¹ say that between faces 11 and 13, is arbitrarily selected on the drawing paper at a convenient distance under the plan. To find the direction of this edge in the perspective drawing note where the zone 11-13 (dotted line) cuts the guide-line (the point X) and join this point to the angle-point.² The direction of the required edge will be perpendicular to the line so obtained; it is lettered DD' in the figure.

The direction of the edge having been obtained, its length is determined from the plan as follows: In a convenient position such as K draw a line parallel to the guide-line and with the help of a ruler and triangle draw lines (dotted in the figure) perpendicular to the guide-line from points A and B until they intersect line DD'. The length A'B' between the points of intersection is the length of the required edge between faces 11 and 13. In practice it is unnecessary to draw in the dotted lines. In the same way, to find the edge between 10 and 13, note where the zone containing them cuts the guide-line at W; and take the direction perpendicular to the line joining W to the angle-point. Next draw the edges between 9 and 13, and 12 and 13, thus completing face 13. The edge between 9 and 10 might next be drawn. In this case the zone intersects the guide-line at Y. Then draw the edge between 12 and 9. Now to find the edge between a terminating face and a prism, for example that between faces 9 and 3: Lay one side of the triangle along the direction line (arrow) of the prism face 3; shift it parallel to itself until it passes thru the pole of face 9; note the point Z where this line cuts the guide-line; and take the perpendicular to the

¹ This edge should be a front edge of the crystal. Front and back edges can be easily distinguished, for an edge is never at the back of the drawing except when both the face-poles concerned are behind the guide-line in the gnomonic projection.

² It is not necessary to draw the line connecting X with the angle-point. Lay one leg of a right-angled triangle on the two points; slide the triangle along a straight-edge to the desired position; and draw DD' on the other leg.

line connecting Z and the angle-point. The edge between 9 and 2 is next drawn, the point on the guide-line being X again. Finally the edge between 9 and 1 is drawn, thus completing face 9. In the same way the directions and lengths of all the edges in the perspective drawing are obtained.

A perspective drawing obtained by Goldschmidt's method is indistinguishable from one derived by the axial-cross method; and the time required to draw an average crystal is about one third (or even less) of that needed with the older methods.

As an example of the simplicity of the Goldschmidt method, a drawing is given of an anorthite crystal (Fig. 19, p. 92) showing thirty forms, together with its gnomonic projection. In this particular case instead of plotting the φ and ρ values from chord and tangent tables, a new gnomonic chart (based on a 5 cm. unit circle) has been used, designed by the author in order to save even more time.¹ It must be noted that the printed graduated circle does not represent the circle of projection. It is drawn with a 10 cm. radius so as to insure greater accuracy in marking off the φ values. The linear distance (5 times nat. $\tan \rho$) corresponding to the angular ρ reading of each face is found with a pair of dividers from a horizontal scale printed at the top of the chart, on the lines recommended for the stereographic projection by Penfield. The angle-point is printed, as also dots which when joined give the guide-line. The latter is not printed in, as occasionally the standard position² for drawing the crystal is not suitable because one or more faces disappear if their poles fall on the guide-line, or become too narrow if their poles are too close to the guide-line. In such cases a new and more appropriate position of the guide-line may be found by trial, which need not differ widely from the usual position.³

The preparation of a gnomonic projection from single-circle measurements is not so direct as in the case of two-circle measurements. In the former case, as is well known, it is an easy matter to prepare a stereographic projection, especially when a stereographic net is available. From this the gnomonic projection may be derived by a method previously described in this series (page 76). It may be noted here that Professor Goldschmidt's method was adapted by Stöber to the stereographic projection.

¹ See advertising page ii.

² The standard position accepted by most crystallographers for the perspective drawing is the one in which the crystal appears as if rotated $18^{\circ}26'$ to the left and inclined $9^{\circ}28'$ forward. In the chart the rotation is 20° and forward inclination about 10° .

³ See Figs. 20 and 21 on page 95. In Fig. 20 we have a projection of a crystal whose poles 1 and 2 are nearly intersected by the guide-line, which faces accordingly practically disappear in the perspective drawing. In figure 21 we have the same projection with the guide-line so shifted that the poles 1 and 2 are no longer so close to it. Having drawn the guide-line the angle-point is found as before but in reverse order. Draw OJ parallel to the guide line and FOE perpendicular to it. With radius DJ draw the arc intersecting OF at the angle-point, G.P.

This adaptation¹, simplified by Viola² and fully worked out by Penfield,³ altho not so accurate as the original method based on the gnomonic projection, can be confidently recommended to users of the one-circle goniometer as being much superior to the axial-cross method generally described in the text-books. It should also be noted here that in the paper by Penfield just referred to there is a presentation of Goldschmidt's method of crystal drawing in a rather different form from that of the present paper. Any student who intends to master the art of crystal drawing would do well to read with great care both this

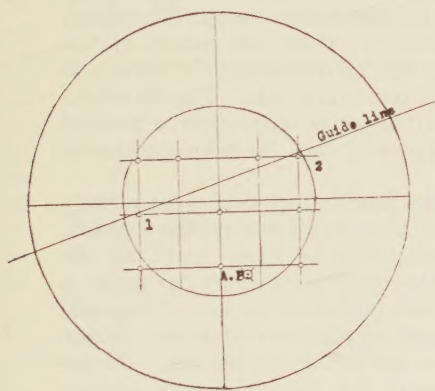


FIG. 20.

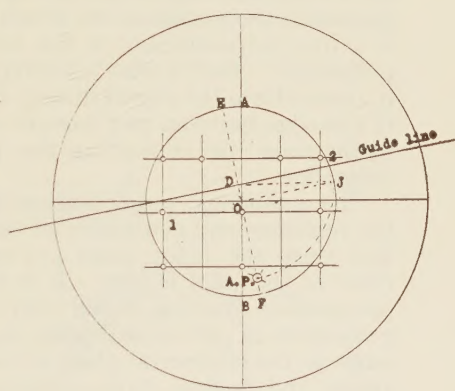


FIG. 21.

and other articles on that subject by this master of crystallography.

Enough has been said to illustrate the great simplicity of construction and the rapidity of execution of crystal drawings resulting from the ingenious application of the gnomonic projection by Professor Goldschmidt.

When one takes into account the enormous number of drawings made annually by crystallographers the world over, the conclusion is irresistible that the new method of drawing is one of the most valuable aids to practical crystallography that has yet been devised.

In conclusion, it gives me pleasure to have an opportunity to thank Mr. T. Vipond Barker, lecturer in chemical crystallography, for most valuable suggestions and criticisms in connection with preparation of the above account.

¹ Stöber, F., *Bull. soc. franc. min.* 22, 42, 1899.

² Viola, C., *Grundzüge der Kristallographie*, 29, 1904.

³ Penfield, S. L., *Am. Jour. Sci.*, 21, 206, 1906.

FURTHER NOTES ON CRYSTAL DRAWING

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1. GEOMETRICAL BASIS OF GOLDSCHMIDT'S METHOD

The orthogonal projection or plan of a crystal is a projection upon the gnomonic projection-plane from an eye-point considered as at an infinite distance, vertically above the crystal. Now a crystal edge, regarded as the axis of a zone, appears in gnomonic projection as the *central* of the zone (see p. 73), which is a line perpendicular to the zone line thru the center of the projection. Such a line, however, will be unchanged in direction if viewed from the stated direction; hence the rule: The direction of the edge between two faces in orthogonal projection is normal to the zone line containing the poles of the faces in gnomonic projection.

The orthogonal projection on the base brings out most clearly the relations and symmetry of the terminal faces of the crystal. But since the prism faces are projected as lines much of the relief of the solid is lost. It is therefore customary to make a perspective drawing which may be regarded as an orthogonal projection of the crystal upon a plane inclined at some chosen angle to the horizontal plane of the gnomonic projection. Experience and custom have established the rule that this chosen plane (we will call it the figure-plane) shall be normal to a line of sight, which is raised about ten degrees above the horizontal and deviates to the right of the front and back direction of the crystal about twenty degrees. It is to be noted, however, that this is an arbitrary position and in what follows nothing precludes the placing of the figure-plane in any position whatever. Its position is fixed by drawing in the gnomonic projection a straight line representing the trace or line of intersection of the chosen figure-plane with the gnomonic projection plane. The figure-plane is assumed to pass thru the center of the sphere of projection; its trace is called the guide-line, the standard position of which is shown in the figures illustrating the preceding article.

Goldschmidt's method of drawing solves the following problem: To find from the gnomonic projection of two face-poles the direction of their edge after being projected orthogonally upon the figure-plane and then transferred into the plane of the drawing. The proof and figures here given follow Boeke (*Gnom. Proj.*, p. 43.)

In the perspective Fig. 22 let F' and G' be two face-poles, Z' the zone which they define, and F , G , and Z the gnomonic projection of the same; L' is the figure-plane with the trace LL in the gnomonic projection. The line $SS'M$ is the line of inter-

AB, whose angle-point is the extremity of the diameter perpendicular to AB. Each of these two figures will be related to the orthogonal projection on the base in the same way as shown in the drawing for the parallel-perspective figure.

AN AMERICAN OCCURRENCE OF SARCOPSIDE

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In 1868 M. Websky published a description of a new mineral, which he named sarcopside.¹ It occurred under a thin covering of vivianite in a pegmatite dike intruding a gneiss formation, near Michelsdorf in the Eulengebirge, Silesia, associated with hureaulite. This has been regarded, however, by Dana and others as closely related to, if not an impure variety of, triplite, and specific rank has not been assigned to it.

A recent examination of a mineral found in Deering, N.H., in 1916, led the author to believe it to be sarcopside, with which it agreed closely in blowpipe and physical properties. A quantitative analysis of this mineral was therefore made, which not only confirmed this belief, but also indicated that it actually represents an independent species.

This first American occurrence (the second known for the mineral) is in a small pegmatite dike, cutting a gray schist composed of sillimanite, muscovite and garnet. This dike has been prospected for mica, and it was on the dump that two small specimens of sarcopside (approximately 3 x 3 x 2 cm. and 2 x 2 x 1 cm.) were found. The pegmatite was composed largely of orthoclase and quartz, with opaque apple-green beryl, black tourmaline, large plates of muscovite and flakes of biotite, and rather large opaque red garnets. No other phosphates than sarcopside were noted, altho no exhaustive search was made.

Sarcopside is a mineral of fibrous appearance, occurring in irregular slab-like masses. It has a distinct cleavage approximately perpendicular to the fibers, and another less distinct parallel to the fibers. The fibers extended continuously across the specimens at hand. The fracture is splintery to fibrous. $H. = 4$. $Sp. Gr. = 3.64$, (average of five determinations on the Jolly balance; Websky gives $sp. gr. = 3.69-3.73$). Luster silky and glistening. Color, when unaltered, flesh-red to lavender; altering on exposure to blue, green, or brown. Translucent in thin splinters. Streak light straw yellow. Alters quite easily on surface to a material resembling and perhaps identical with "blue vivianite."

The optical properties of sarcopside have not been previously recorded, and it was thought essential, to confirm its specific

¹ *Z. Deutsche Geol. Ges.*, 20, 245, 1868.

rank, to determine some of these. Under the microscope the cleavage fragments appear to be flat fibers of two kinds; first, a group in which the perfect cleavage makes an angle of 90° with the elongation of the fibers; and a second group in which this angle measures $84^\circ \pm 1^\circ$. This second group is composed of those fibers which are broken off in such a way that the flat side is parallel to the imperfect cleavage; the others have their flat sides approximately perpendicular to both cleavages, due to an irregular fracture in that direction. The extinction angle measured from the elongation of the fibers is in the first case 45° , while in the second set the extinction is 6° – 7° . The mean refractive index is 1.725 ± 0.005 , by the immersion method. The birefringence is very weak, the rather thick cleavage fragments showing upper 1st and lower 2d order interference colors, while the more finely powdered material shows 1st order gray.¹

The blowpipe reactions are identical with those of triplite, for it contains the same elements, tho in different proportions, as shown below.

The material selected for analysis appeared perfectly fresh, transparent and homogeneous under the microscope. The analysis of the New Hampshire mineral is compared with that of Websky in tables 1 and 2.

TABLE 1
ANALYSES OF SARCOPSIDE

	1a.	1b.	1c.	2a.	2b.
Fe ₂ O ₃ ..	1.77– 1.62	1.70	.021	8.83	.110
FeO..	39.91–39.83	39.87	.554	30.53	.424
MnO..	10.90–10.75	10.83	.152	20.57	.290
CaO..	4.42– 4.33	4.38	.078	3.40	.060
MgO..	0.68	0.68	.017	—	—
P ₂ O ₅ ..	33.44–33.08	33.26	.234 = 2.00	34.73	.245 = 2.00
F....	4.35	4.35	.229 = 1.96	undet.	—
H ₂ O..	1.54– 1.52	1.53	—	[1.94]	—
insol..	3.39– 3.04	3.22	—	—	—
		99.82		100.00	
	less O = F	1.83			
		97.99			

1a. Duplicate analyses of sarcopside from Deering, N. H., by author.

1b. Average analysis of same.

1c. Molecular ratios of same.

2a. Analysis of sarcopside from Michelsdorf, Silesia, by M. Websky.

2b. Molecular ratios of same.

In both of these analyses the author has changed Fe₂O₃ to its equivalent of FeO, in calculating the molecular ratios; for undoubtedly the ferric iron was formed by the oxidation of

¹ Websky suggested that the crystal system is monoclinic; the present data do not conflict with this view, yet in the lack of information as to the orientation of the fragments, the system must be regarded as not definitely determined.

original ferrous iron. All ferrous iron and manganese phosphates alter very readily and give poor molecular ratios if not calculated in this way. The acid-insoluble of the American mineral is nearly all silica, with a few minute flakes of mica. The larger percentage of Fe_2O_3 in Websky's sarcopside is explained by the presence in his material of "particles giving a green streak" indicating that alteration had proceeded further than in the New Hampshire mineral, which is very nearly unaltered in the interior.

Websky derived a complicated formula which may be reduced to the generalized formula, $4\text{R}_3\text{P}_2\text{O}_8.\text{RF}_2.\text{Fe}_2\text{O}_3.\text{H}_2\text{O}$, where R is Mn, Fe, or Ca. In the New Hampshire mineral all the water is driven off below 110° and is to be regarded as non-essential and the fluorine present is sufficient to satisfy the molecular ratio; hence the author believes the formula to be $2\text{R}_3\text{P}_2\text{O}_8.\text{RF}_2$. Websky did not determine the fluorine, tho recognizing its presence, and arrived at his formula by a "consideration of the fluorine present."² He determined water by difference, and therefore fluorine is contained in the percentage assigned to water, and if equivalent oxygen is deducted enough fluorine could easily be present to give the formula $2\text{R}_3\text{P}_2\text{O}_8.\text{RF}_2$ or $\text{R}_7\text{F}_2(\text{PO}_4)_4$ with R = Fe, Mn, Ca, and Mg. How well the recalculated analyses agree with the theory for this formula is shown in table 2.

TABLE 2
COMPOSITION OF SARCOPSIDE

	1.	2.	3.
FeO.....	44.51	38.48	62.19
MnO.....	11.64	20.57	—
CaO.....	4.70	3.40	—
MgO.....	0.73	—	—
P_2O_5	35.72	34.73	35.09
F.....	4.67	—	4.70
	101.97	—	101.98
O = F	1.97	—	1.98
	100.00	—	100.00

1. Analysis of sarcopside from New Hampshire, after removing water and insoluble matter, converting ferric to ferrous oxide, and recalculating to 100%.

2. Websky's analysis of the material from Silesia, with ferric converted to ferrous oxide.

3. Theoretical composition of sarcopside, if R = Fe only. Agreement between the values obtained and those calculated is excellent.

In refutation of the view of many authorities that sarcopside is merely altered triplite, it should be noted that the material

¹ Dana, *System Min.*, Ed. 5, App. 1, p. 14.

² *Neues Jahrb. Min. Geol.*, 1868, 606.

analyzed by the author had been altered but very little. It may be well to consider, too, the properties that distinguish sarcopside from triplite. Chemical analysis shows the formula of sarcopside to be $2R_3P_2O_8 \cdot RF_2$, as compared to that of triplite, $R_3P_2O_8 \cdot RF_2$; in both of them R is Fe, Mn, Mg, or Ca. Triplite is massive, with a small conchoidal fracture, resinous to adamantine luster; color brown to blackish brown; and has a yellowish gray to brown streak. Sarcopside is fibrous; with a fibrous to splintery fracture; silky and glistening luster; color flesh red to lavender; and streak light straw yellow. Of great importance in distinguishing the two is the mean refractive index, which is 1.660 in triplite and 1.725 in sarcopside. The author believes on this evidence that sarcopside is entitled to rank as an independent species.

The relation between the formula of sarcopside and those of other minerals containing the same elements is brought out in table 3.

TABLE 3

COMPARISON OF FORMULA TYPES OF FLUOPHOSPHATES OF Fe" AND MN

Ratios			Typical Representatives	Related Minerals
R"	F,OH	(PO ₄)		
3	0	2	Graftonite	_____
5	1	3	(Apatite group)	_____
7	2	4	Sarcopside	Ludlamite, $Fe(OH)_2(PO_4)_4 + 8H_2O$.
2	1	1	Triplite	Triploidite, $Fe_2(OH)(PO_4)_4$.
5	4	2	_____	Dihydrate, $Cu_5(OH)_4(PO_4)_2$.
3	3	1	_____	Pseudomalachite, $Cu_3(OH)_3(PO_4)_4$.

It is noteworthy that sarcopside lies midway between triplite and apatite (or at least a theoretical Fe-Mn-apatite) in composition. It is possible that the unnamed ferrous fluophosphate from Stoneham, Maine¹ may be the missing member of the apatite group; or it may lie midway between sarcopside and that group, and possess the ratio 12:3:7. On the other hand both this mineral and the so-called "griphite" may well be impure forms of sarcopside, which they approach far closer than they do triplite, with which they are usually grouped. Another interesting fact is that just as triplite has its hydroxyl representative, triploidite, so sarcopside has ludlamite (which contains, however, water of crystallization, and therefore does not correspond exactly).

The material at hand is very limited, but the author intends to investigate this locality more thoroly in the near future, paying special attention to the possibility of more sarcopside and of other iron and manganese phosphates occurring there.

¹ Dana, *System Min.*, Ed. 6, 778, line 45.

PROCEEDINGS OF SOCIETIES NEW YORK MINERALOGICAL CLUB

Regular Monthly Meeting of Wednesday, March 10, 1920

The regular monthly meeting of the New York Mineralogical Club was held in the Assembly Room of the American Museum of Natural History on the evening of March 10th, at 8.15 P.M. The President, Dr. George F. Kunz, presided and there was an attendance of 25 members. Mr. Robert Oppenheimer, of 155 Riverside Drive, was proposed for membership. The Secretary drew attention of the members present to the recently organized Mineralogical Society of America and the President suggested that the Club become a corporate member of this Society. The President announced the death on February 27 of Professor Alfred J. Moses of Columbia University, and the President, the Secretary, and Mr. Frederick I. Allen spoke of the life and work of Professor Moses and their association with him. It was moved by Mr. Stanton that the Secretary send the following resolution and expression of sympathy from the Club to the family of the late Professor Moses:

"By the death on February 27, of Alfred J. Moses, Professor of Mineralogy at Columbia University, the science of mineralogy has lost one of its most eminent and valued exponents. Professor Moses' work as a teacher, as a writer and as a scientific investigator can hardly be too highly esteemed and his loss to all branches of his profession is most keenly felt. His text book (with C. L. Parsons) on "Mineralogy, Crystallography and Blowpipe Analysis" will for many years remain the standard in a large majority of the Universities in which courses in these subjects are given. His work "The Characters of Crystals" published in 1899 is the first treatise published in America upon Physical Crystallography, a branch of Crystallography which was early recognized by him as of primary importance to chemists, geologists and mineralogists and which has within very recent years assumed a scope and developed practical applications which have more than justified his early visions of its future.

The research work of Professor Moses was marked by a conservative distaste for announcing a result until he had thoroughly verified it. This admirable tendency was also evidenced in the terseness and finished quality of his statements of fact, whether written or spoken. He was seldom under the necessity of erasing a word from his lecture notes or modifying a statement made to any one consulting him, whether student or scientist.

His personal dealings were marked by a large sympathy coupled with a modesty which was almost shrinking in its avoidance of the prominence which was by reason of his attainments thrust upon him. Yet his vision and enthusiasm for his science were such as to inspire those who worked in close touch with him, and who will long treasure his memory as a master in science, as a man of large ideas and high attainments and as a sympathetic and valued friend."

The President exhibited and described a recently found occurrence of chrysolite from the Napali Coast, Kauai, Sandwich Islands. Proceeding to the discussion of the evening on "Zeolitic and associated minerals from the New Jersey Localities," Mr. Hoadley showed a number of Paterson minerals

from the lower quarries (Mc Kennon) and drew attention to the fact that the minerals from these quarries were darker in color than those from the Mercer Quarries. Mr. Grenzig showed some unusual occurrences of datolite from Great Notch, and apophyllite from Mercer's quarry, West Paterson. He also exhibited unusual groupings of prehnite from West Paterson, quartz pseudomorphs after glauberite, apophyllite and calcite from Mercer's Quarry. Mr. Whitlock exhibited 5 undescribed examples of parallel grouping of calcite from the Bergen Archways and Paterson. Captain Miller showed a number of microscopic mounts of Paterson minerals.

Miss Luther exhibited agate from Upper Montclair, also stilbite, apophyllite and prehnite. Mr. Oppenheimer at the request of the President showed a geode from Paterson containing nodular rosettes of prehnite which were entirely detached but of the same grouping as the lining of the geode. Mr. R. M. Allen showed prehnite coated with malachite, also crystallized prehnite, a color variation in chabazite and a spherical aggregate of thompsonite. Mr. Broadwell showed red quartz and green datolite from West Paterson. Mr. F. I. Allen drew attention to the work of Professor Moses on the pseudomorphic cavities from Upper Montclair. Mr. Manchester exhibited a large and varied series of interesting specimens including pectolite from the upper quarries of Paterson and pseudomorphic casts of anhydrite. He recalled the collecting at the Erie Cut and spoke of the origin of the loose datolite crystals characteristic of this occurrence. Dr. Kunz spoke of the early days of collecting in the New Jersey zeolite localities with many recollections and anecdotes relating to the collectors who made these occurrences famous.

HERBERT P. WHITLOCK,
Recording Secretary

THE PHILADELPHIA MINERALOGICAL SOCIETY
Wagner Free Institute of Science, March 11, 1920

A stated meeting of the Philadelphia Mineralogical Society was held on the above date with the president, Dr. Burgin, in the chair. Nineteen members and five visitors were present.

Messrs. R. Weckerly, James Rahill, and E. O. C. Acker, upon favorable recommendation of the council, were elected to active membership.

Mr. John Rothermel addressed the society on "The goldfields of Nova Scotia." The geology of the Oldham district was described, and an account given of the occurrence of gold veins, their mineralogy, and possible origin.

SAMUEL G. GORDON, *Secretary*

NOTES AND NEWS

Mr. Charles K. Cabeen, instructor in geology at Syracuse University, has been appointed State Mineralogist of New York and Professor of Mineralogy in Rensselaer Polytechnic Institute.

Dr. Arthur L. Day has resumed his former position as Director of the Geophysical Laboratory of the Carnegie Institution of Washington.

A New Crystal System Name.—For the crystal system possessing three axes of different lengths, lying at right angles, the terms rhombic and orthorhombic are both frequently used. In a recent number of the *Journal of*

Industrial and Engineering Chemistry (February, 1920, page 166), the same system is referred to as "o-rhombic." In order that this shall not be suspected as being a bit of Irish propaganda, we may explain that in organic chemical compounds the prefix *ortho* is commonly abbreviated to "o"; and the use of the same abbreviation here was evidently an oversight.

The mineral collection of the painter Otto Vautier, of Geneva, Switzerland, recently deceased, is offered for sale. It comprizes about 1,200 specimens, including many choice and rare ones, especially from old European localities. It is valued at about 12,000 francs. Correspondence should be addressed to Dr. E. Joukowsky, Assistant in the Museum d'histoire naturelle, Bastions, Geneva, Switzerland.

NEW MINERALS

Bismutoplagonite

EARL V. SHANNON: Bismutoplagonite, a new mineral. *Am. J. Sci.* [4], 49 (3), 166-168, 1920.

NAME: from its composition, a plagonite with Sb replaced by Bi.

PHYSICAL PROPERTIES: Color, bluish lead gray; streak: dull dark brownish gray. Luster: metallic. Opaque. Form: small indistinctly fibrous masses with an ill-defined cleavage parallel to the elongation. $H. = 2.8$. Sp.gr. 5.35.

CHEMICAL PROPERTIES: Composition, $5\text{PbS} \cdot 4\text{Bi}_2\text{S}_3$; a small proportion of Bi replaced by Sb.

Analysis showed: insoluble 18.88, PbS 30.21, As_2S_3 tr., CuS tr., Ag_2S tr., FeS_2 1.25, Sb_2S_3 3.37, Bi_2S_3 45.62, sum 99.33 per cent.

B.B. fuses to a brittle globule on charcoal, and yields a coating which is yellow near the assay and white on the outer portion. With sodium carbonate the mineral is reduced to a metallic button. In closed tube yields a copious sublimate of S, and in the open tube gives abundant SO_2 .

OCCURRENCE: Found near Wickes, Jefferson County, Montana, with pyrite, galena, tetrahedrite, chalcopyrite and quartz. S. G. GORDON

Brannerite

FRANK L. HESS and ROGER C. WELLS: Brannerite, a new uranium mineral. *J. Frank. Inst.*, 189 (2), 225-237, 1920.

NAME: After Dr. John C. Branner.

PHYSICAL PROPERTIES: Color, brilliant black, with a brownish yellow coating due to weathering. Streak: dark greenish brown. Opaque. Form: grains and rough prismatic crystals, probably paramorphs after a tetragonal or orthorhombic form. Fracture conchoidal. Isotropic; $n_{\text{li}} 2.26 \pm 0.02$; $n_{\text{Na}} 2.30 \pm 0.02$ (Larsen). $H = 4.5$. Sp.gr. = 4.50-5.43. Radio-active, the radio activity increasing with the Sp. Gr.

COMPOSITION: A hydrated metatitanate of various bases: $(\text{Ca}, \text{Fe}, \text{UO}, \text{TiO}) \text{TiO}_3 + (\text{Th}, \text{Zr}, \text{UO}) \text{TiO}_3 + \text{Yt}_2 (\text{TiO}_3)_3 + \text{H}_2\text{O}$.

An analysis by Wells gave: SiO_2 0.6, TiO_2 39.0, FeO 2.9, CaO 2.9, UO_2 10.3, UO_3 33.5, ThO_2 4.1, Ce_2O_3 none, Y_2O_3 etc. 3.9, ZrO_2 0.2, PbO 0.2, BaO 0.3, SrO 0.1, H_2O 2.0, CO_2 0.2, Fe_2O_3 , Al_2O_3 , P_2O_5 tr., sum 100.2%. The high uranium content is noteworthy. The mineral appears to be a metatitanate, essentially $(\text{UO}, \text{TiO}, \text{UO}_2) \text{TiO}_3$ similar to delorenzite but differing from it in the high UO_3 content.

OCCURRENCE: Found in gold placers near granites cut by pegmatite, near the head of Kelly Gulch, Stanley Basin, central Idaho. S. G. GORDON

ABSTRACTS—CRYSTALLOGRAPHY

THE APPROXIMATION OF REFRACTIVE INDICES. R. PANE-
BIANCO. *Riv. min. crist. Ital.*, **47**, 3-9, 1916.

It is shown mathematically (in Esperanto), that figures beyond the third decimal place are without significance. E. T. W.

DISCUSSION OF TOPIC AXES AND OF A NEW CHEMICAL
THEORY OF IGNEOUS ROCKS. R. PANEBIANCO. *Riv. min. crist. Ital.*, **47**, 9-21, 1916.

It is shown (in Esperanto) that the numerical coincidences which frequently occur in the study of topic axes are of far less significance than certain writers have supposed. E. T. W.

CRYSTALLOGRAPHIC STUDIES OF THE NICKEL AND MAG-
NESIUM TETRATHIONATE OCTOHYDRATES WITH HEXAME-
THYLENETETRAMINE. C. PERRIER. *Riv. min. crist. Ital.*, **47**, 22-30,
1916.

These salts have the formula-type $RS_4O_6 \cdot 8H_2O \cdot 2C_6N_4H_{12}$, with $R = Mg$ or Ni . They are monoclinic, with the following ratios: Ni -salt, $a : b : c = 0.8541 : 1 : 0.6668$; $\beta = 97^\circ 21\frac{1}{2}'$; forms (010), (110), (210), (101), ($\bar{1}01$) and ($\bar{1}21$). Mg -salt, $a : b : c = 0.8512 : 1 : 0.6755$; $\beta = 97^\circ 26'$; forms (010), (110), (101), and ($\bar{1}21$). The densities and molecular volumes of the Ni and Mg salts are respectively: 1.608, 455.03; and 1.519, 459.08. A close isomorphism is thus shown between Ni and Mg , both in crystallization and molecular volume; the same relation has been observed in a number of sulfates and selenates of these metals. E. T. W.

CRYSTALLOGRAPHIC STUDIES OF LITHIUM MERCURIC
HALIDES WITH HEXAMETHYLENETETRAMINE. E. QUERCIGH.
Riv. min. crist. Ital., **47**, 30-39, 1916.

These salts have the formula type $2LiR.HgR_2 \cdot 8H_2O \cdot 2C_6N_4H_{12}$, with $R = Cl, Br$, or I . Their crystallographic features are as follows: Chloride, monoclinic, with $a : b : c = 0.7130 : 1 : 0.7682$; $\beta = 79^\circ 42'$; forms (100), (010), (001), (110), (011), and ($\bar{1}21$). Bromide, triclinic, with $a : b : c = 0.5627 : 1 : -$; $\alpha = 123^\circ 30'$, $\beta = 94^\circ 01'$, $\gamma = 88^\circ 58'$; forms (100), (010), (001), (110), and ($\bar{2}10$). Iodide, rhombic, with $a : b : c = 0.6917 : 1 : 0.7336$; forms (100), (010), (001), (101), (110), and (011). In spite of the difference in system, these compounds are isomorphous to some extent, as brought out by comparisons of angles between certain forms. E. T. W.

THE SPECTRAL PHOTOELECTRIC SENSITIVITY OF MOLYB-
DENITE. W. W. COBLENTZ, M. B. LONG, AND H. KAHLER. *Phys. Rev.*,
11, 497, 1918.

The presence of maxima of sensitivity is noted and the influence of temperature upon them is described. Molybdenite from different localities varies greatly in sensitiveness. E.T.W.

SOME OPTICAL AND PHOTOELECTRICAL PROPERTIES OF MOLYBDENITE. W. W. COBLENTZ and H. KAHLER. *U. S. Bur. Standards Sci. Paper* **338**, 1919.

Data are given of the transmissivity and reflectivity of molybdenite, and its change in electrical conductivity when exposed to thermal radiations of wave lengths extending from ultra-violet to extreme infra-red. S. G. G.

CRYSTALS FOR SOUND AMPLIFICATION. A. McL. NICOLSON. *Elec. Rev.*, **74**, 954, 1919.

PIEZO-ELECTRICITY AND ITS TECHNICAL APPLICATION. J. S. G. THOMAS. *J. Soc. Chem. Ind.*, **38** (9), 159-160 R, 1919.

PIEZOELECTRICITY AND ITS APPLICATIONS. J. J. THOMSON. *Engineering*, **107**, 543-544, 1919.

Discussions of the use of crystals without centers of symmetry, especially rochelle salt, quartz, and tourmaline, for generating electric currents when exposed to sound or other vibrations. E.T.W.

ABSTRACTS—MINERALOGY.

CHIEF MINERALS OF THE SUDBURY NICKEL ORES. ARTHUR P. COLEMAN. *Canadian Mining J.*, **37** (16), 386-389, 1916.

The nickel-bearing minerals found are pyrrhotite, pentlandite, polydymite, gersdorffite, millerite, and niccolite. The nickel content of the pyrrhotite is due to finely disseminated pentlandite. Chalcopyrite is an abundant associate. L. S. RAMSDELL, W. F. HUNT.

PYROPHYLLITIZATION, PINITIZATION, AND SILICIFICATION OF ROCKS AROUND CONCEPTION BAY, NEWFOUNDLAND. A. F. BUDDINGTON. *Jour. Geol.*, **24**, 130-152, 1916.

The formation of pyrophyllite, pyrite and other minerals in rhyolite by the metasomatic action of circulating waters from an intrusive granite batholith is described. L. S. R., W. F. H.

OCCURRENCE, GEOLOGY, AND ECONOMIC VALUE OF THE PITCHBLEND DEPOSITS OF GILPIN COUNTY, COLORADO. PERCY R. ALSDORF. *Econ. Geology*, **11**, 266-275, 1916.

Comprises a brief discussion of the uses and properties of radium; descriptions of the mode of occurrence of the pitchblende, together with gold and silver sulfides. L. S. R., W. F. H.

THE PYROXENE WHICH FORMS AN INTERMEDIATE LAYER BETWEEN THE NEPHELINE AND THE MICA IN THE GEODES OF THE LIMESTONE OF MONTE SOMMA. G. CÉSARO. *Riv. min. crist. Ital.*, **47**, 78-85, 1916; abstr. reprinted by permission from C.A. **13** (17), 1991-1992, 1919.

The crystallographic and optical properties of this pyroxene are given, and it is shown to be an iron-bearing diopside related to hedenbergite. Similar data are also given on another pyroxene and a vesuvianite crystal with unusual birefringence. The minerals in the residue obtained on treating the limestone with acid are described, one being pleonaste and another a pyroxene with interesting optical properties. E. T. W.

A SERIES OF TREATISES ON THE RARE METALS; TUNGSTEN, MOLYBDENUM, VANADIUM, URANIUM. HERMAN FLECK. *Proc. Colo. Sci. Soc.*, 11, 103-176, 1916.

An excellent summary of data on the above metals. The minerals containing them are described as to properties, methods of identification, occurrence, etc. C. B. SLAWSON, W. F. H.

GEOLOGY OF KINGSTON (ONTARIO) AND VICINITY. M. B. BAKER. *Ontario Bur. Mines, 25th Annual Rept.*, part 3, 1-36, 1916.

This district is famous for the large number of minerals, at least 53, which have been reported; they include graphite, gold, arsenic, copper galena, sphalerite, talc, corundum, molybdenite, fluorite, pyrite, apatite, mica, feldspar and barite. L. S. R., W. F. H.

CHEMICAL AND MINERALOGICAL COMPOSITION OF METEORITES (ABSTRACT). G. P. MERRILL. Discussion by O. C. FARRINGTON. *Bull. Geol. Soc. Am.*, 27, 50, 1916.

Traces of the following rarer elements were found to be present in meteorites: iridium, platinum, palladium, ruthenium, and vanadium. Negative tests were obtained for antimony, arsenic, barium, gold, lead, strontium, tin, tungsten, uranium, zinc, and zirconium. In the discussion Farrington suggested that radium should be added to the list of elements found in meteorites. W. F. H.

ZINC CARBONATE AND RELATED COPPER CARBONATE ORES AT OPHIR, UTAH. G. F. LOUGHLIN. *U. S. Geol. Survey, Bull.* 690, 1-14, 1917.

The principal minerals present are ferruginous smithsonite, aurichalcite, malachite and azurite. The following interesting features were noted: (a) the marked lamellar structure of the zinc carbonate, (b) the prevailing absence of calamine, and (c) the intimate association of the zinc carbonate with copper carbonates. The zinc sulfate solution, the result of the oxidation of ferruginous zinc blende, invaded the limestone along fractures and replaced the rock by smithsonite. W. F. H.

THE ORIGIN AND OCCURRENCE OF CERTAIN CRYSTALLOGRAPHIC INTERGROWTHS. W. H. GOODCHILD. *Econ. Geol.* 11, 397-402, 1916.

The author finds examples of the micropegmatitic structure in the copper-nickel ores of the Insizwa Range, E. Griqualand, S. Africa. He believes that this structure is due to a purification or squeezing out of one mineral along lines of weakness such as cleavage planes, and suggests that similar intergrowths elsewhere might also indicate deposition of ore from a state of fusion rather than from mineralizing solutions. W. F. H.

THE TERNARY SYSTEM CaO-MgO-SiO_2 . J. B. FERGUSON AND H. E. MERWIN. *Proc. Nat. Acad. Sci.*, 5, 16-18, 1919; *Am. J. Sci.* [4], 48, 81-123, 1919.

An elaborate account of the thermal relations of this system, including data on the formation and properties of the compound $2\text{CaO} \cdot \text{MgO} \cdot 2\text{SiO}_2$, which resembles the mineral oakermanite. E. T. W.